# U.S. GEOLOGICAL SURVEY

# RESEARCH/DEVELOPMENT SCIENTIST RECORD

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|---|---|---|
| 1. | **NAME** | **Edward H Field** |
| 2. | **DATE PREPARED** | January 17, 2014 |
| 3. | **DUTY STATION** | Golden, CO |
| 4. | **REGION** | Central |
| 5. | **CLASSIFICATION TITLE, SERIES, & GRADE** | Research Geophysicist GS-1313 GS-15 |
| 6. | **DATE OF ENTRANCE ON DUTY** | July 1, 2000 |
| 7. | **DATE OF LAST PROMOTION** | July 7, 2005 |
| 8. | **DATE OF LAST RESEARCH GRADE PANEL REVIEW** | January, 2013 |

9. **EDUCATION**

| | | | |
|---|---|---|---|
| University of Colorado – Boulder, | Geology, | 1983-1988 | B.A. with honors, 1988. |
| Columbia University - New York, | Geological Sci. | 1988-1990 | M.A., 1990. |
| Columbia University - New York, | Geological Sci. | 1990-1994 | Ph.D., 1994. |

10. **TECHNICAL TRAINING RECEIVED**

11. **PROFESSIONAL EXPERIENCE**

a. **PRESENT ASSIGNMENT** (Summarize the project(s) with which you are currently associated, your role in the project(s), and the major source of funding.)

**Introduction:**

My primary responsibility is to conduct research and develop seismic hazard models for use in the USGS National Seismic Hazard Mapping Program (NSHMP), with California being by primary area of responsibility. To this end, I lead two main complementary projects: 1) *OpenSHA* (http://www.OpenSHA.org), a computational infrastructure for conducting Seismic Hazard Analysis (SHA); and 2) the Working Group on California Earthquake Probabilities (http://www.WGCEP.org). These projects constitute primary venues for implementing basic research, which I also conduct, with the goal being the quantification (and ultimate reduction) of seismic risk for society. These projects also represent close collaborations with academia, mostly through the Southern California Earthquake Center (SCEC).

**Leadership of OpenSHA: A Computational infrastructure for Seismic Hazard Analysis (http://www.OpenSHA.org): Aug. 2001- present**

In the past, new seismic hazard models were generally implemented by duplicating and modifying existing codes, which was inefficient, time consuming, and difficult to manage. This was particularly problematic in that significant SHA improvements will require not only more physics-based approaches, but also a greater number of alternatives models (to better represent uncertainties). To solve this problem I initiated *OpenSHA* (Pub. #35; http://www.OpenSHA.org), an object oriented, open-source, and freely available computational infrastructure for SHA, where any new model can "plug in" for analysis without having to change what's being plugged into. As such, OpenSHA is effectively a community-developed Lego set, where different modules can plug together in new and innovative ways. A variety of applications are currently available (here), all of which are platform independent, web-enabled, and optionally graphical-user-interface based. OpenSHA also utilizes advanced information technologies. I continue to lead this activity, and specific accomplishments are listed below.

*~30% of my time is spent on this project. Mark Petersen is my official supervisor.*

**The SCEC Information-Technology Research (ITR) Collaboration (http://www.scec.org/cme): 2001 - present**

In 2001 SCEC received a 5-year, $10M grant from NSF to develop an advanced IT infrastructure, which has since grown into a "Community Modeling Environment" or "Collaboratory" for physics-based SHA. Of the many activities, I focus here on those relating to OpenSHA. Through this collaboration, we have enabled any OpenSHA component (model or database) to exist as a geographically distributed and runtime-accessible "Web Service" or "Distributed Object" (see Pubs #37 and #38). Not only does this make inevitable data and model revisions easier to handle (i.e., change things only in once place), it also keeps our applications lightweight because most information exists elsewhere. Another ITR accomplishment (Pubs. #39 & #40) is the use of "GRID" computing for hazard-map calculations, where any idle UNIX computers at USC are automatically accessed on the fly, thereby reducing computation times by more than an order of magnitude. Trouncing that

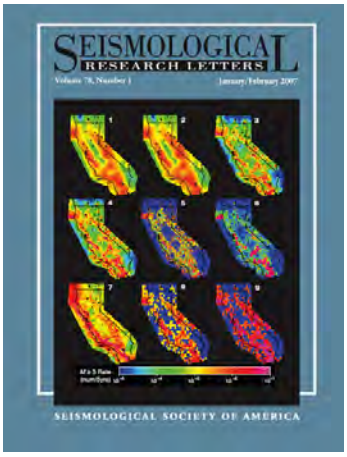
performance gain by orders of magnitude, we've also utilized the TeraGrid super computer - "the world's largest, most comprehensive distributed cyberinfrastructure for open scientific research" (http://www.teragrid.org). And most recently, we were using NFS's brand new super computer (*Stampede*, said to have "unprecedented computational capabilities") just two days after its January 7, 2013 deployment (http://www.tacc.utexas.edu/stampede).

*I helped write the original proposal and I am the primary USGS collaborator. Thomas Jordan (the SCEC director) is the PI. Mark Petersen is my official supervisor. I spend ~10% of my time on this project.*

**Collaboratory for the Study of Earthquake Predictability (CSEP), and its evolution from RELM: July 2000 – present**

Previous official earthquake forecasts for California, such as the Working Groups on California Earthquake Probabilities (WGCEP, 1988, 1992, 1995) and the USGS NSHMP, used a single or a narrow range of models. Although 2002 WGCEP made progress by utilizing an extensive logic-tree to represent uncertainties, these were still within the confines of some basic model assumptions (e.g., segmenting and characteristic earthquakes). As mentioned above, excluding viable models is problematic in terms of representing full uncertainties.

In 2000 I therefore initiated and led the RELM project (http://www.RELM.org) to develop a wider range of models. Rather than forcing consensus, participants were free to build whatever models they believed in (some with more physics). The 17 resulting models were published in a special issue of *Seismological Research Letters* (Jan/Feb 2007), along with an overview paper written by myself (Pub. #41 below). Rather than forcing consensus, RELM was basically an experiment with a competitive "free-market" approach to building models.



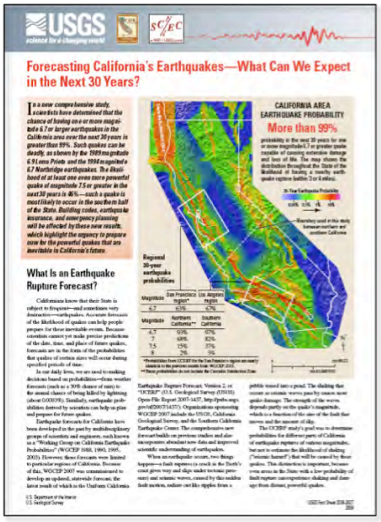
**RELM Special Issue**

An important part of RELM was the submission of forecasts for formal, independent testing (describe in the special issue). This has since grown into the international Collaboratory for the Study of Earthquake Predictability (CSEP; http://www.cseptesting.org/), which I continue to actively participant in.

*~5% of my time is spent on this project. Mark Petersen is my official supervisor.*

**Leadership of the Working Group on California Earthquake Probabilities (WGCEP; http://www.wgcep.org): Sept. 2004 - present**

The RELM "free-market" approach has proven problematic for users at a loss in choosing among multiple models. For example, the California Earthquake Authority (CEA) is legally required use "best available science" in setting their earthquake insurance rates, so the WGCEP here makes this determination for California.




**UCERF2 Fact Sheet**

Between 2004 and 2008, and with $1,750,000 from CEA, I led the WGCEP development of Uniform California Earthquake Rupture Forecast, version 2 (UCERF2; Pubs #43, #44, #45, #46, & #47). Notably, this was the first model to use uniform methodologies across the state (a legal requirement for CEA). Between the main report, 16 appendices, and formal reviews, more than 50 scientists from the USGS, SCEC, and the CGS were involved. UCERF2 has since been used to update building codes and to set insurance rates.

UCERF2 highlighted several inadequacies that we are currently addressing in UCERF3, which I also lead with $2,000,000 from CEA. Far from an incremental update, UCERF3 involves several major innovations, including spatiotemporal clustering (e.g., damaging aftershocks, as dramatized by the 2010 2011 Christchurch, NZ earthquake). This capability will enable Operational Earthquake Forecasting, one of the strategic-action priorities for the USGS (http://pubs.usgs.gov/of/2012/1088; page 31). Again, more than 50 scientists are involved.

*50% of my time is spent on this project. Mark Petersen is my official supervisor.*

**Other Activities: July 2000 – present**

I am of course involved in basic scientific research related to the above activities (included in the time percentages given above). As a member of SCEC's planning committed, I also spend considerable time contributing to their science plan, writing the RFP, and evaluating proposals.

*~5% of my time is spent on these activities. Mark Petersen is my official USGS supervisor.*

## b. PREVIOUS PROFESSIONAL POSITIONS

**August 1998 – January 2001**

**Working-Group Leader for the SCEC Phase III Effort** to examine how site amplification can be incorporated in SHA, published as a special issue of a peer reviewed journal with fact sheet and poster (Pubs #30, #31, #32, #33, & #34).

**July 1999 – June 2000**

**Research Associate Professor** in the Department of Earth Science at the University of Southern California. I conducted independent research and wrote proposals to fund this research.

**August 1996 – June 1999**

**Research Assistant Professor** in the Department of Earth Science at the University of Southern California. I conducted independent research and wrote proposals to fund this research.

**September 1994 – August 1996**

**SCEC Postdoctoral Research Fellow** at USC. The title of my proposal was "Toward a better understanding of site-response in terms of seismic hazard assessment …".

**September 1988 – August 1994**

**Graduate Research Assistant** at the Lamont-Doherty Earth Observatory of Columbia University. I conducted independent and supervised research.

## 12. SIGNIFICANT RESEARCH ACCOMPLISHMENTS

## a. RECENT ACCOMPLISHMENTS

**OpenSHA Development (see Present Assignment above for project summary):**

Following the initial design, review, and documentation of OpenSHA, we implemented several cutting-edge models and provided various applications for conducting earthquake-hazard and risk related analyses. Any success we've achieved should be measured by the usefulness of OpenSHA, so here is a list of *some* of our accomplishments since 2008:

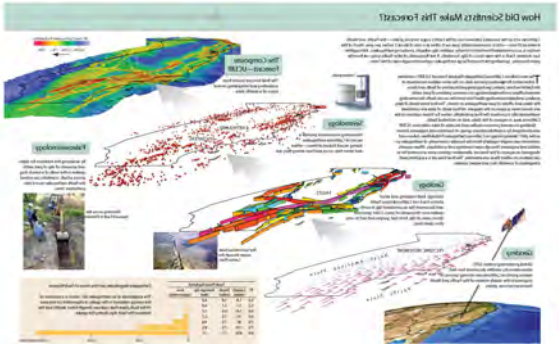
- Implementation of all UCERF3 components (some specifics are given in the next section).
- Implementation of statewide probabilistic loss calculations for California, enabling the quantification of which UCERF2 model uncertainties contribute most to loss uncertainties. See Pub #50.
- *WGCEP-2007's UCERF2 Implementation* – This forecast model, arguably the most advanced ever developed (before UCERF3), was created using OpenSHA. This gave us unprecedented flexibility in supporting different models (logic tree branches) and in enabling real-time access to various remotely located data resources. Once implemented, the model could be plugged into any of the various

OpenSHA applications (for hazard or loss analysis), which gave us the unprecedented ability to explore implications while building the model (e.g., helpful in deciding logic-tree weights). No other code can handle SHA calculations for UCERF2 without significantly "dumbing it down".

- *California Reference Geologic Fault Parameter Database*– Part of the WGCEP-2007 effort was the development of an Oracle database containing comprehensive geologic and paleoseismic data for California. Using OpenSHA, we developed graphic-user-interface (GUI) tools that allow anyone, anywhere, to view or potentially edit the data. Also, by combining our code with that of another Java development (SCEC-VDO), we created a tool that allows users to view the faults of California in 3D (which turned out to be indispensible in terms of data verification). This collaboration exemplified the power of object-oriented design in terms of sharing "Lego pieces" with other code developments. All of these applications are available at http://wgcep.org/tools.
- *Access to High-Performance Computing* – As noted above, most recently we used NFS's newest super computer, *Stamped* (http://www.tacc.utexas.edu/stampede), just two days after its deployment on Jan 7, 2012 (as noted above).
- *Implementation of the Next-Generation Attenuation (NGA) Relationships* – These latest, greatest ground-motion-prediction equations, published in Earthquake Spectra (Feb. 2008), have been available in OpenSHA since 2008. The "NGA2" models are also now implemented.
- *Code Verification* – Our code has also been extensively validated against the USGS NSHMP Fortran code (e.g., see Figure 2 of Pub. #39). We have also successfully participated in a PSHA-code verification exercise conducted by the Pacific Earthquake Engineering Research Center. Finally, we have made extensive use of J-unit testing (the Java standard), where the code can be automatically checked for errors following any changes.
- *Other Accomplishments* can be found at http://www.OpenSHA.org.

**WGCEP Developments (see Present Assignment above for project summary):**

On April 14, 2008, the Working Group on California Earthquake Probabilities (WGCEP 2007) publicly released the Uniform California Earthquake Rupture Forecast, Version 2 (UCERF2). The development of this model was a joint effort between Southern California Earthquake Center (SCEC), the USGS, and the California Geological Survey (CGS), with considerable support from the California Earthquake Authority (CEA). The model was review by an independent Scientific Review Panel and both the National and California Earthquake Prediction Evaluation Councils (NEPEC and CEPEC). The main report, 16 appendices, executive summary, supplemental data, press release, footage of the press conference, and a fact sheet are all available at http://www.SCEC.org/ucerf. The main report was also published in a peer-reviewed journal - the *Bulletin of the Seismological Society of America* (Pub #47).

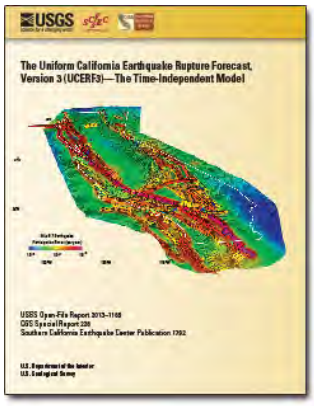


**From UCERF2 Fact Sheet:**

An important accomplishment of WGCEP 2007 was establishing a uniform statewide model. Moreover, UCERF2 development was carefully coordinated with the National Seismic Hazard Mapping Program (NSHMP), with a time-independent version of UCERF2 being used in the 2008 hazard maps, and thereby impacting building codes. The time-dependent model has also been used by CEA for setting earthquake insurance rates and purchasing reinsurance.

The UCERF2 project highlighted the following scientific issues that I have since been addressing in the ongoing UCERF3 development (described above):

1) An over-prediction of earthquakes near magnitude 6.7 suggests that UCERF2 is overly "segmented" and lacking multi-fault ruptures, the likelihood of which has since been strongly suggested by the 2010 M 7.2 El Mayor-Cucapah earthquake and the 2011 M 9.0 Tohoku earthquake. I first-authored a prototype solution to this problem in 2011 (Pub #49), which forms the basis of the "Grand-Inversion" solution that has now been implemented for UCERF3 (Pubs #52 & #53). This is a radically different approach relative to previous WGCEPs, both in terms of being a system-level solution (solve for the rate of all earthquake simultaneously rather than separately), and in terms of being derivative rather than prescriptive (let the inversion produce all models that are consistent with data rather than assuming one narrow range of models). After extensive review, this new model has been formally adopted for use in the 2014 National Seismic Hazard Maps.




2) The classic form of time-dependence implemented in previous WGCEP is based on Reid's elastic rebound theory (where probabilities go down due to stress release after and earthquake and build back up with time as stresses re-accumulate). However, in Publication 44 below I demonstrated that the algorithm used by previous WGCEPs (including UCERF2), is not self consistent, and therefore cannot be strictly correct. As part of UCERF3, I have now developed a solution to this problem, based in part on the analysis of physics-based earthquake simulators (e.g., Pub #51). Three different manuscripts have been written on this, currently under review by our Scientific Review Panel, and various aspects have been presented at professional meetings (listed below) and in CEA progress reports.

3) For inclusion of spatiotemporal clustering (triggered events and aftershocks), I have developed an Epidemic Type Aftershock Sequence (ETAS) model for use in UCERF3. The biggest challenge was merging finite-fault-based forecasts with traditional point-process ETAS models. In so doing, I believe I have also demonstrated that you cannot include triggering statistics without also including elastic-rebound effects, basically because large earthquakes would be way more likely to re-trigger the fault that has just ruptured rather than a different fault, which we just doesn't occur in nature. This is ironic because the advocates of triggering statistics have argued that there is no evidence for elastic rebound; it would appear that their statistics are indeed that evidence. The model is fully implement (in *OpenSHA*) and has been presented at three meetings (listed below) and in progress reports. Further road testing, formal review, and publication await completion of the above UCERF3 components.

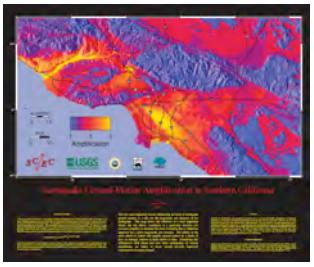
**b. OTHER CAREER ACCOMPLISHMENTS** (Briefly list other major research contributions during remainder of career. Limit to 2 pages.)

**OpenSHA Development (those before 2008):** Following the extensive design, formal review, and initial implementation, we published an overview of the framework in *Seismological Research letters* (Pub. #35). Over subsequent years we published papers exemplifying how others could use our various applications to do cutting edge analysis on their own. For example, Pub. #36 showed how our Scenario ShakeMap Calculator could be used (with HAZUS software) to compute losses for any earthquake; our choosing a worst case scenario, the Puente Hills fault underneath LA, turned out to be of high interest

following hurricane Katrina (discussed further below as one of my three most significant publications). Another publication (Pub. #37) showed how our Hazard Curve Calculator provides access to the WGCEP-2002 time-dependent model (or any of the 10,00 logic-tree branches), something that no other code has ever accomplished. This manuscript, along with Pub #38, also exemplified the use of distributed object technologies, where the NSHMP-2002 Fortran code was "wrapped" in Java and hosted on a server, which our applications then accesses from anywhere on the fly. Other accomplishments, including the use of OpenSHA to compute the probability that aftershocks of the 2002 Denali earthquake would cause additional offsets of the Alaska oil pipeline, are given at http://www.OpenSHA.org.

**The SCEC Phase III Effort (1998-2001):** This project focused on how site effects can be accounted for in seismic hazard analysis. I was the leader of this working-group effort, which involved more than 20 scientists from various institutions. Our results were published as 14 papers in a special issue of the *Bulletin of the Seismological Society of America* (Dec., 2000). I was the guest editor for the special issue, first author of the 31-page overview paper (Pub. #32), first author of two other technical papers (Pubs #30 & #31), first author of a USGS Fact sheet on the results (Pub. #33), and I gave the main presentation at a well-attended press conference (see http://www.scec.org/instanet/01news/feature010205.html). I also developed some web-based applications for use by engineers and practicing professionals (this activity spawned OpenSHA). The Phase III project significantly improved in our ability to delineate which regions of southern California will experience more or less shaking, on average, during earthquakes. Equally important, the study helped clarify what types of research are needed to further improve ground-motion predictions. In fact, this report is often cited when referring to the need for a more physics-based approach to SHA (e.g., 2003 NRC report *Living on an Active Earth: Perspectives on Earthquake Science*). This study received ~$2,000,000 from the NSF, USGS, and Caltrans, as well as considerable internal resources from the USGS and CDMG.

**Amplification Map for Southern California:** This map, a product of the SCEC Phase III effort published as a *USGS OFR* (Pub. #34), has appeared in the following places: the front page of the Los Angeles Times Metro section; two USGS fact sheets (001-01 and 017-03); the 2004 edition of "Putting Down Roots in Earthquake Country"; and in Patrick Abbott's "Written in Stone" television series (http://www-rohan.sdsu.edu/~wis/).



**Nonlinear Sediment Response:** Discussed as one of my three notable publications below (so I refrain from repeating myself here).

**Earthquake Deficit Problem in Southern California:**

The first attempt to integrate geologic, geodetic, and seismic information into a composite model of earthquake occurrence predicted a rate of magnitude 6 to 7 earthquakes twice as great as that observed historically (Working Group on California Earthquake Probabilities, 1995, *Bull. Seis. Soc. Am.* **85**, 379-439). One solution proposed to remove the discrepancy involved allowing "huge" (M≥8) earthquake to occur, not only on the San Andreas Fault, but on smaller regional faults as well (Jackson, 1996, *Seism. Res. Lett.* **67**, 3-5). Geologist argued, however, that there is no evidence for such huge earthquakes, and that they would be hard to hide (e.g., Schwartz, 1996, *Seism. Res. Lett.* **67**, 5-6). Several papers have addressed this "earthquake deficit" problem. In particular, Stein and Hanks (1998, *Bull. Seism. Soc. Am.* **88**, 635-652) showed that historical seismicity is consistent with regional deformation rates provided a proper inventory of earthquakes is taken. In spite of these studies, geologically based seismicity models

continued to predict a rate of earthquakes greater than has been observed historically (including the official hazard maps produced by CDMG and the USGS; Petersen et al., 1996, *USGS OFR 96-706*).

Building on the previous studies, I first-authored a solution to this problem (Pub #28). A simple, geologically based approach for constructing a hazard source model that agrees well with the historical record, and does not invoke any unsubstantiated phenomena (including huge earthquakes) was presented. A forensic-type analysis of what went wrong in the 1995 Working-Group model was also provided. About a half-dozen factors were found to be influential, including the b-value chosen, a round-off error in the moment-magnitude relationship, the lower magnitude limit, the percentage of moment put into characteristic versus Gutenberg-Richter seismicity, and as noted by Stein and Hanks earlier, a bias in the historical earthquake catalog. None of these factors alone caused or solved the previous earthquake deficit problem. It was combined effect that created the discrepancy. Our results were discussed in *Science* (July 10, 1998), *Nature* (August 27, 1998)*;* and *Science News* (March 21, 1998). It should be acknowledged that this issue reared its ugly head again in WGCEP-2007's UCERF2 (discussed above).

**General Site Response Studies:**

The research related to my Ph.D. thesis at Lamont Doherty resulted in seven first-authored publications in peer-reviewed journals (Pub. #s 1, 5, 9, 10, 11, 13, & 14). These addressed various issues related to site response estimation, including systematic evaluations of various empirical estimates (e.g., sediment to bedrock spectral ratios, horizontal to vertical component rations, and generalized inversion estimates). I also made extensive evaluations of the use of ambient seismic noise, both on the basis of empirical observations and a theoretical model that I developed (Pub # 10). These helped verify that ambient noise is quite useful for determining the resonant frequency of sediments, but not useful for determining amplification factors. I also developed a Monte Carlo methodology for propagating parameter uncertainties into theoretical site response estimates (Pub. # 9).

During my SCEC Postdoc I analyzed data that I collected in the Coachella Valley, California following the 1992 Landers earthquake. These data contain some of the strongest observations of basin-edge induced waves ever recorded. I made a systematic evaluation of the influence of basin waves on various site response estimates, showing, among other things, that coda site response estimates over-predict amplification levels (Pub. # 16). I also made extensive use of the data to construct a structural cross section of the valley (Pub. # 15), including the application of receiver-function type analyses with local events (a first as far as I am aware). As a postdoc I also quantified the spatial variability of ground motion at a dense array deployed in the San Fernando Valley following the 1994 Northridge earthquake (Pub. # 17).

**Field Work:**

I have participated in numerous seismometer deployments, including those related to the following events: the 1988 Armenian earthquake, the 1989 Loma Prieta earthquake, the 1992 Landers earthquake, and the 1999 Izmit earthquake in Turkey.

## 13. SCIENTIFIC LEADERSHIP

I am currently leading the multi-agency Working Group on California Earthquake Probabilities (http://www.WGCEP.org) described *ad nauseam* above.

I am also currently leading OpenSHA (http://www.OpenSHA.org) also described *ad nauseam* above.

I previously led the working group for the development of Regional Earthquake Likelihood Models (http://www.RELM.org), which produced a special issue of Seismological Research Letters (described above).

I also led the previous SCEC Phase III effort (http://www.scec.org/phase3/) that led to a special issue of the *Bulletin of the Seismological Society of America* on "Accounting for Site Effects in Probabilistic Seismic Hazard Analyses of Southern California" (described above).

I am also the primary USGS collaborator on the SCEC information Technology Collaboration for the development of a Community Modeling Environment (http://epicenter.usc.edu/cmeportal/index.html).

I have served on the planning committee of the Southern California Earthquake Center (SCEC) from 2000 to present (first four years as Focus-Group Leader for Seismic-Hazard-Analysis, and since then as the leader of the WGCEP "special project"). This involves helping to formulating the SCEC science plan, writing the annual RFPs, and reviewing and recommending funding levels for all SCEC proposals.

I provided leadership on SHA software development for the Global Earthquake Model (GEM) project as a formal member of their Model Advisory Group (MAG; not to be confused with my GEM "TAP" role listed below).

I have advised five postdocs since arriving at the USGS (Greg Anderson, Karen Felzer, Morgan Page, Peter Powers, and Anna Olsen), two of which were Mendenhall recipients, and the other three for which I obtained funding.

On a somewhat lesser note, I have also chaired many special sessions at annual meetings of the Seismological Society of America and the American Geophysical Union.

## 14. SCIENTIFIC AND PUBLIC SERVICE

### a. CURRENT MEMBERSHIPS IN PROFESSIONAL SOCIETIES

| | |
|---|---|
| Earthquake Engineering Research Institute | 1991 - present |
| American Geophysical Union | 1989 - present |
| Seismological Society of America | 1989 - present |

**b. TECHNICAL PRESENTATIONS** (Note: only 1st authored abstracts are listed)

Field, E.H., S.H. Hough, and K.H. Jacob (1989). Sediment Amplification in Flushing Meadows, New York: Applications of an Ambient Noise Method, *Fall meeting of the American Geophysical Union*; *EOS Trans, AGU*, **70**, p. 1192. PRESENTED

Field, E.H., K.H. Jacob, and S. H. Hough (1991). Earthquake Site Response Estimation: A Case Study Using Aftershocks of the 1989 Loma Prieta Earthquake Recorded in Oakland, Ca., *Fall meeting of the American Geophysical Union, EOS Trans, AGU*, **72**, p. 338. PRESENTED

Field, E.H., K.H. Jacob, N. Barstow, and P.A. Friberg (1992). Preliminary Results from a Site Response Study Conducted in the Coachella Valley Following the Landers and Big Bear Earthquakes, *Fall meeting of the American Geophysical Union, EOS Trans, AGU*, **73**, p. 383. PRESENTED

Field E.H., and K.H. Jacob (1993). The Response of Sedimentary Layers to Ambient Seismic Noise: A Theoretical Model and Comparison with Both Observations and the Response Predicted for Earthquake Ground Motion, *Fall meeting of the American Geophysical Union, EOS Trans, AGU*, **74**, p. 422. PRESENTED

Field, E.H., A.C. Clement, V. Aharonian, P.A. Friberg, L. Carroll , T.O. Babaian, S.S. Karapetian, S.M. Hovanessian, and H.A. Abramian (1993). Earthquake Site Response Study in Giumri (formerly Leninakan), Armenia Using Ambient Noise Observations, *Int. Conf. on Continental Collision Zone Earthquakes and Seismic Hazard Reduction,* Oct. 1-6, 1993, Yerevan, Armenia. PRESENTED

Field E.H., and K.H. Jacob (1993). Monte Carlo Simulation of the Theoretical Site Response Variability at Turkey Flat, Given Uncertainty in the Input Parameters, *Spring 1993 Seis. Soc. of Am. meeting*, Ixtapa-Zihuatanejo, Mexico. PRESENTED

Field, E.H., and K.H. Jacob (1994). The Response of Sedimentary Layers to Ambient Seismic Noise: A Theoretical Model and Comparison with Both Observations and the Response Predicted for Earthquake Ground Motion, *1994 IASPEI meeting in Wellington, New Zealand.* PRESENTED

Field, E.H., (1994). A Comparison of Three Site Response Estimation Techniques, *1994 Annual Meeting of the Seismological Society of America*., Pasadena, California, USA. PRESENTED

Field, E.H., (1994). Basin-Edge Induced Surface Waves in the Coachella Valley, *Fall meeting of the American Geophysical Union* , *EOS Trans, AGU*, **75**, p. 440. PRESENTED

Field, E.H., and S.E. Hough (1995). The Variability of Response Spectra Across an Array Deployed in the San Fernando Valley During the Northridge Aftershock Sequence, *Fall meeting of the American Geophysical Union* , *EOS Trans, AGU*, **76**, p. 352. PRESENTED

Field, E.H., (1995). Site Response Estimates In The Coachella Valley, *1995 Annual Meeting of the Seismological Society of America*., El Paso, Texas, USA. PRESENTED

Field, E.H. (1995). Using Ambient Noise to Estimate Earthquake Site Response; An Update, *1995 Meeting of the International Union of Geodesy and Geophysics,* Boulder Colorado, USA. PRESENTED

Field, E.H. (1996). Strong Basin-Edge Induced Waves in the Coachella Valley: An Opportunity to Test Various Simulation Techniques?, *11th World Conf. on Earthquake Engineering*, 23-28, June 1996, Acapulco, Mexico. PRESENTED

Field, E.H. , A. Papageoriou and G. Dong (1996). Strong Basin-Edge Induced Waves in the Coachella Valley: Observations and Modeling, *Fall meeting of the American Geophysical Union* , *EOS Trans, AGU*. PRESENTED

Field, E.H. , Y. Zeng, P.A. Johnson, and I. A. Beresnev (1997). Pervasive Nonlinear Sediment Response Observed During the 1994 Northridge Earthquake, *Fall meeting of the American Geophysical Union* , *EOS Trans, AGU*, 78, p. 46. PRESENTED

Field, E.H., D.D. Jackson, and J.F. Dolan (1998). A Mutually Consistent Seismic-Hazard Source Model for Southern California: No Deficit or M>8 Earthquakes Required, *Fall meeting of the American Geophysical Union* , *EOS Trans, AGU*, 79, p 584. PRESENTED

Field, E.H., D.D. Jackson, and J.F. Dolan (1998). An Integrated Seismic-Hazard Source Model For Southern California: No Deficit or M>8 Earthquakes Required, *1998 Annual Meeting of the Seismological Society of America*, Boulder, Colorado. PRESENTED

Field, E.H., D.D. Jackson, and J.F. Dolan (1999). An Integrated Seismic-Hazard Source Model For Southern California, *1999 Meeting of the International Union of Geodesy and Geophysics,* July, 1999, Birmingham, UK.

Field, E.H., and the SCEC Phase III Working Group (2000). Accounting for Site Effects in Probabilistic Seismic Hazard Analysis: Overview of the SCEC Phase III Report, *12th World Conference on Earthquake Engineering*, January, 2000, Auckland, New Zealand.

Field, E.H., and the SCEC Phase III Working Group (2000). Accounting for Site Effects in Probabilistic Seismic Hazard Analysis: Overview of the SCEC Phase III Report, *2000 Annual Meeting of the Seismological Society of America*, San Deigo, California. INVITED.

Field, E.H., M.D. Petersen, and N.A. Abrahamson (2000). A Test of Various Site Response Parameterization in Probabilistic Seismic Hazard Anaysis, *2000 Annual Meeting of the Seismological Society of America*, San Deigo, California. INVITED.

Field, E.H., and the SCEC Phase III Working Group (2000). Accounting for Site Effects in Probabilistic Seismic Hazard Analysis: Overview of the SCEC Phase III Report *Proc. of the 6th Int. Conference on Seismic Zonation*, Nov. 12-15, Palm Springs, California, USA. PRESENTED

Field, E.H., and the SCEC Phase III Working Group (2000). Accounting for Site Effects in Probabilistic Seismic Hazard Analysis: Overview of the SCEC Phase III Report *Fall meeting of the American Geophysical Union* , *EOS Trans, AGU*, 81, p. 820. PRESENTED

Field, E.H. (2001) RELM - A Working Group for the Development of Regional Earthquake Likelihood Models, *2001 Annual Meeting of the Seismological Society of America*, San Francisco, California. PRESENTED

Field, E.H. (2001). RELM (the Working Group for the Development of Region Earthquake Likelihood Models) and the Development of new, Open-Source, Java-Based (Object Oriented) Code for Probabilistic Seismic Hazard Analysis. *Fall meeting of the American Geophysical Union*, *EOS Trans, AGU*, 82(47), Abstract S41C-12**.** PRESENTED

Field, E.H. (2002) A Map of Site Amplification in the Los Angeles, California Region Based on the SCEC Phase III Report, *2002 Annual Meeting of the Seismological Society of America*, Victoria, BC Canada.

Field, E.H. and T.H. Jordan (2002). Creating a Distributed, Community-Modeling Environment in Support of the Working Group for the Development of Regional Earthquake Likelihood Models (RELM). *Fall meeting of the American Geophysical Union*, *EOS Trans, AGU*, 83(47), Abstract NG52A-07 INVITED**.**

Field, E.H. and T.H Jordan (2003) OpenSHA: A Developing, Community Modeling Environment for Seismic-hazard Analysis (2003). *2003 Annual Meeting of the Seismological Society of America*, San Juan, Puerto Rico. PRESENTED

Field, E.H., N. Gupta, V. Gupta, P. Maechling, and T.H. Jordan (2003). OpenSHA: Community Tools for Seismic Hazard Analysis. *Fall meeting of the American Geophysical Union*, *EOS Trans, AGU*, 84(47). PRESENTED

Field, E.H., N. Gupta, V. Gupta, P. Maechling, and T.H. Jordan (2004). Community Tools for Seismic Hazard Analysis. *2004 annual meeting of the Earthquake Engineering Research Inst*, Feb. 4-7, Los Angeles, CA. PRESENTED

Field, E.H., T.H. Jordan, and D.D. Jackson (2004). A Developing System-Level Earthquake-Rupture Forecast for Southern California, *2004 Annual Meeting of the Seismological Society of America*, April 14-16, Palm Springs, CA. PRESENTED

Field, E.H. and T.H. Jordan (2004) OpenSHA: A Developing, Community-Modeling Environment for Seismic-Hazard Analysis, *13th World Conference on Earthquake Engineering*, Aug. 1-6, 2004, Vancouver, BC, Canada. PRESENTED

Field, E.F. (2004). A Progress Report on the Working Group for the Development of Regional Earthquake Likelihood Models (RELM), *2004 Fall meeting of the American Geophysical Union*, http://www.agu.org/meetings/fm04/fm04-sessions/fm04_S21C.html. PRESENTED

Field, E.F. (2005). A Review of Previous Working Groups on California Earthquake Probabilities, *2005 Fall meeting of the American Geophysical Union*, *Eos Trans. AGU, 86*(52), Fall Meet. Suppl., Abstract S41D-01. INVITED

Field, E.F. (2005). Overview of the Working Group for the Development of Regional Earthquake Likelihood Models (RELM), *2005 Fall meeting of the American Geophysical Union*, *Eos Trans. AGU, 86*(52), Fall Meet. Suppl., Abstract S42B-02. PRESENTED

Field, E.F. (2006). The Working Group on California Earthquake Probabilities (WGCEP) Plan for Developing a Uniform California Earthquake Rupture Forecast (UCERF), 2006 *Meeting of the Seismological Society of America*, April 18-22, San Francisco, CA. PRESENTED

Field, E.F. (2007). Progress of the Working Group on California Earthquake Probabilities (WGCEP), 2007 *Meeting of the Seismological Society of America*, April 11-13, Hilton Waikoloa Village, Hawaii. PRESENTED

Field, E.H., T. Dawson, K. Felzer, A. Frankel, V. Gupta, T. Jordan, T. Parsons, M. Petersen, R. Stein, R. Weldon, C. Wills. (2008). The Uniform California Earthquake Rupture Forecast Version 2, *2008 Meeting of the Seismological Society of America*, April 16-18, Santa Fe, NM. INVITED

Field, E.F. (2008). Future WGCEP Models and the Need for Earthquake Simulators, *2008 Fall meeting of the American Geophysical Union*, *Eos Trans. AGU, 89*(53), Fall Meet. Suppl., Abstract S32A-01 INVITED.

Field, E.H. (2009). Overview of OpenSHA, *Kickoff Meeting for the development of the Global Earthquake Model, version 1 (GEM1)*, March 3-5, 2009, Canberra, Australia.

Field, E.H. and M.T. Page (2009). A Relatively Simple, Objective, and Extensible Methodology for Developing Probabilistic Earthquake Rupture Models for a Fault or Fault System, *2009 Meeting of the Seismological Society of America,* April 8-10, Monterey, CA; abstract on line. PRESENTED.

Field, E.H. (2009). Uniform California Earthquake Rupture Forecast 2 (UCERF 2) & Plans for UCERF3, *6th International Workshop on Statistical Seismology*, April 12-16, 2009, Lake Tahoe, CA. INVITED.

Field, E.H. (2009). Scientific Challenges in Developing the Next Uniform California Earthquake Rupture Forecast (UCERF3), *Abstract S43C-01 presented at 2009 Fall Meeting, AGU*, San Francisco, CA, 5-9 Dec. abstract on line. PRESENTED.

Field, E.H. (2010). Development of an Official Operational Earthquake Forecast for California (UCERF3 by the ongoing WGCEP), *2010 Meeting of the Seismological Society of America*, April 21-23, Portland, OR; abstract on line. PRESENTED.

Field, E.H. (2011). Computing Elastic-Rebound-Motivated Earthquake Probabilities on an Un-segmented Fault, *2011 Meeting of the Seismological Society of America*, April 13-15, Memphis, TN; abstract on line. INVITED

Field, E.H. (2011). Development of UCERF3 Implies that Spatiotemporal Clustering Constitutes the Strongest Evidence for Elastic Rebound?, *6th International Workshop on Statistical Seismology*, May 25-28, 2011, Santorini, Greece. INVITED.

Field, E.H. (2011). Aftershock Statistics Constitute the Strongest Evidence for Elastic Rebound in Large Earthquakes? *Abstract S22B-08 presented at 2011 Fall Meeting, AGU*, San Francisco, CA, 5-9 Dec. abstract on line. PRESENTED.

Field, E.H. (2011). The Use of Simulators by the WGCEP, *APEC Cooperation for Earthquake Simulation (ACES) Workshop on Advances in Simulation of Multihazards*, Maui, Hawaii, May 1-5, 2011. INVITED.

Field, E.H. (2012). Aftershock Statistics Constitute the Strongest Evidence for Elastic Relaxation in Large Earthquakes—Take 2, *2012 Meeting of the Seismological Society of America*, April 17-19, San Diego, CA; abstract on line. PRESENTED.

Field et al. (2012). Overview of the Regional Earthquake Likelihood Models (RELM), *Collaboratory for the Study of Earthquake Predictability Workshop on RELM Final Evaluation and the Future of Earthquake Forecasting*, June 7, 2012, Rancho Mirage, CA.

Field et al. (2012). Making Earthquake Forecasting in California Actually Operational (by operationalizing UCERF3), *Collaboratory for the Study of Earthquake Predictability Workshop on RELM Final Evaluation and the Future of Earthquake Forecasting*, June 7, 2012, Rancho Mirage, CA.

Field, E.H. (2013). The Uniform California Earthquake Rupture Forecast Version 3 – Key Assumptions and Testability, *2013 Meeting of the Seismological Society of America*, April 17-19, Salt Lake City, UT. INVITED

Field et al. (2013). Overview Of The Uniform California Earthquake Rupture Forecast Version 3 (UCERF3) Time-Independent Model, *Abstract S51F-04 presented at 2013 Fall Meeting, AGU*, San Francisco, CA, 9-13 Dec. PRESENTED.

*The above list does not include many presentations given at various WGCEP- and/or SCEC-related workshops and meetings (at least one a month, on average)*

## c. RENDERING SCIENTIFIC JUDGMENT

(*chronological order here*)

I gave a presentation and served on a panel to discuss "New Developments in Hazard Estimation" at the *Sixth International Conference on Seismic Zonation* held in Palms Springs, California (Nov. 11-15, 2000).

At an invitational workshop on NEHRP post-earthquake investigations organized by the ATC, EERI, and USGS, I was the moderator and a participant for Panel #8, which addressed the question of "*What Research and Data Collection Activities during the Post-earthquake Research Phase are Inadequately Covered by NEHRP?*" March 13-14, 2001.

I was asked and agreed to give a presentation to the USGS "top brass", as well as Canadian counterparts, at a meeting on "*New Technologies in Earthquake Hazards Research*" held in Menlo Park on Nov. 21, 2001. The title of my talk was "Building an Infrastructure for Improved Seismic Hazard Analysis".

I was asked and agreed to give a presentation on "Knowledge Transfer in the Context of Seismic Hazard Analysis" at the *EarthScope Information-technology Workshop* held in Snowbird, Utah on March 25-27, 2002.

In both FY2002 and FY2003, I served on the EHPR (aka, NEHRP) External Research proposal-evaluation panel for southern California.

I was one of seven individuals asked to provide an official, technical review of the WGCEP-2002 Report (Earthquake Probabilities in the San Francisco Bay Region: 2002–2031, *By* Working Group On California Earthquake Probabilities, U.S.G.S. Open-File Report 03-214; http://geopubs.wr.usgs.gov/open-file/of03-214/). I believe I was the only reviewer asked to give a secondary evaluation as well (which turned out to be the final review), and I'm very sure I was the only one who also reviewed their Fortran code line by line.

I've been asked to give presentations to the *Scientific Earthquake Studies Advisory Committee* (SESAC, which reports directly to the director of the USGS) on the following occasions:

- June 11-12, 2003 at USC
- April 14, 2005 at USGS, Menlo Park
- Feb. 19, 2008 at USGS, Reston
- March 29-30, 2012, Reston

I was asked to provide a technical review of "*Real-time forecast of Tomorrow's Earthquakes in California: a New Mapping Tool*" by Gerstenberger, Wiemer, and Jones (USGS OFR 2004-1390; *Nature* **435**, 328-331 (19 May 2005), http://earthquake.usgs.gov/eqcenter/step).

I was asked to give a keynote address on "Lessons from OpenSHA's effort to develop a community modeling environment for SHA" at the *2004 annual IRIS meeting*.

I was invited to speak on "Collaborative SCEC/USGS Efforts to Improve Seismic-Hazard Analysis: RELM and OpenSHA" at the 6th U.S.-Japan Natural Resources (UJNR) Panel on Earthquake Research (Oct. 12-16, 2004, Asilomar, CA)

I was invited to speak on "OpenSHA – Community Tools for Seismic Hazard Analysis" at the meeting on *Open-source catastrophe risk modeling: How can we do it better?* March 15-16, 2005*,* Cupertino, CA.

I was invited to participate in several meetings related the Next Generation Attenuation (NGA) Relationship development managed by the Pacific Engineering Research Center in the years 2005 to 2007.

I was asked to give a 45-minute talk on "Building an Infrastructure for Putting Physics-Based SHA into Practice (Examples from California)" at the meeting *Earthquake and Shaking Probabilities – Helping Society to Make the Right Choice* in Erice (Sicily), Italy, October 18-24, 2006.

I was asked to speak on OpenSHA's open-source software development at the *1st International Workshop on Open-Source Risk Software* at Caltech on Feb 27-28, 2007.

I was asked to give a presentation on OpenSHA and to participate in a panel discussion at the 2007 Workshop of the Natural Hazard Center in Boulder, CO. July 11-12, 2007.

I was asked by the *Reinsurance Association of America* to give a keynote address on "Overview of the Latest Uniform California Earthquake Rupture Forecast" at their Feb 19-22, 2008 meeting on Cat [bond] Modeling.

I was asked by the *Reinsurance Association of America* to participate in a panel discussion of "Do We Model Worldwide Earthquake Risk Properly?" at their Feb 19-22, 2008 meeting on Cat [bond] Modeling.

I was asked to contribute to an international planning meeting for the development of the Global Earthquake Model (GEM). June 14-16, 2008, and have since participated in several other GEM planning meetings that are not listed elsewhere on this document.

I was asked to make a presentation on anticipated future WGCEP models to the *National Earthquake Prediction Evaluation Council (NEPEC)* on Sept. 10, 2008.

I was asked to present the UCERF2 model and future WGCEP plans to the *NRC Committee on Seismology and Geodynamics* at Caltech on Oct. 27, 2008.

Between Feb. 2008 and July 2010 I served as one of three members of the International Evaluation Committee (IEC) for the Seismological projects being funded by the *Italian Dept. of Civil Protection* in cooperation with the *Instituto Nazionale di Geofisica e Vulcanologia* (Agreement INGV-DPC 2007-2009). We provide independent oversight of this SCEC-like project.

Since Oct. 2010 I have served as a member of the Technical Advisory Panel (TAP) for hazard model development in the Global Earthquake Model project.

I was asked to present "WGCEP developments toward Operational Earthquake Forecasting" to the *National Earthquake Prediction Evaluation Council (NEPEC)* on Sept. 17, 2012.

I was invited to participate in the "Powell Working Group on Seismic Hazard Modeling", a series of small meetings at the USGS John Wesley Powell Center in Fort Collins, CO (one in Aug 2012 and another planned for July 2013).

I gave an invited talk and served on a panel to discuss Operation Earthquake Forecasting to the 2012 COSMOS Technical Session (Consortium of Organizations for Strong Motion Observation Systems) Nov. 16, Hilton Garden Inn, Emeryville, CA.

I was asked to speak as a "proponent expert" on multi-fault ruptures at the Diablo Canyon Seismic Source Characterization Workshop 2 (part of relicensing a nuclear power plant there), Nov 8, 2012, Embassy Suites, San Luis Obispo, CA.

I was invited to, attended, and presented at two sets of USGS Powell Center meetings on "Joint USGS-GEM Group on Global Probabilistic Modeling of Earthquake Recurrence Rates and Maximum Magnitudes" (July 8-10 and Sept 4-6, 2013); these meetings are limited to about a dozen participants.

As is true for all of us, I peer-review manuscripts for several professional journals on a regular basis.

## d. LECTURESHIPS AND OTHER ACADEMIC SERVICE

University of Colorado, Boulder - General talk to the Earth Sci. Dept., March, 1995.

USGS, Golden - Technical talk, March, 1995.

University of Nevada, Reno - General talk to the Earth Sci. Dept., April, 1995.

University of California, Berkeley - General talk to the Earth Sci. Dept., April, 1995.

USGS, Menlo Park - Technical talk, April, 1995.

University of California, Santa Barbara - Tech. talk at the Inst. of Crustal Studies, April, 1995.

San Diego State University - General talk to the Earth Sci. Dept., September, 1995.

California Institute of Technology - Tech. talk at the Seismic Lab., September, 1995.

California State University, Fullerton - General talk to the Earth Sci. Dept., October, 1995.

Oregon State University - General talk to the Oceanography and Geology Depts., April, 1996.

California Institute of Technology - Tech. talk at the Seismic Lab., July, 1997.

USGS, Menlo Park - Technical talk, October, 1997.

University of Southern California - General Talk, September 28, 1998.

University of California, Los Angeles - Technical talk, October 7, 1998.

USGS, Menlo Park – Technical Overview Talk, December 7, 2000.

California Institute of Technology - Tech. talk at the Seismic Lab., Feb. 9, 2001.

University of Southern California – Technical talk for Dept. of Earth Sciences, Feb. 13, 2001.

University of California, San Diego – Technical talk for IGPP, March 30, 2001.

California State University, Fullerton - General talk to the Earth Sci. Dept., May, 14, 2003.

Lamont-Doherty Earth Observatory of Columbia Univ. – Technical Overview Talk, May 19, 2003.

USGS, Menlo Park – Technical Overview Talk, July 26, 2003.

UC Santa Barbara – A variety of talks given to the Geology and Physics departments, Sept., 2004.

Oregon State University – "SHA - A Path to a More Physics Based Approach", April, 2004.

California Institute of Technology – "Physics-Based SHA - Why and How", June, 2004.

UC Riverside – "SHA - A Path to a More Physics Based Approach (state-of-art overview)", May, 2005.

University of Utah – "SHA - A Path to a More Physics Based Approach", March, 2006.

University of Utah – "OpenSHA and the SCEC ITR Collaboration", March, 2006.

USGS Cascade Volcano Obs. – "Seismic Hazard Assessment (state-of-art overview)" April, 2008.

EQECAT Annual Meeting – "Uniform California Earthquake Rupture Forecasts", March, 2009.

USGS, Menlo Park – Dev. of an Operational Earthquake Forecast for CA (UCERF2-UCERF3) July, 2009.

USGS, Golden – "Dev. of an Operational Earthquake Forecast for CA (UCERF2 to UCERF3)" Oct., 2009

CU Boulder – "Building an Official, Operational Earthquake Forecast Model for CA", Feb. 2011.

USGS, Golden – "Building UCERF3, an Operation Earthquake Forecast for CA", Feb. 2011.

SCEC Annual Meeting Keynote – "Progress on an Operation Earthquake Forecast for CA", Sept. 2011.

*I had to cancel several invited talks in 2013 due to USGS travel restrictions*

**e. TECHNICAL TRAINING PROVIDED**

**f. SPECIAL ASSIGNMENTS**

**g. OTHER TECHNICAL ACTIVITIES**

## 15. OUTREACH AND INFORMATION TRANSFER

I developed and remain a primary contributor to the web sites for the WGCEP and OpenSHA:

http://www.WGCEP.org
http://www.OpenSHA.org

Please note that a great deal of my time goes into developing and maintaining these web sites (not to mention the software contained therein); each of which requires more time than a typical publication.

UCERF 2 Release: In addition to being the primary author on the main report and executive summary, I gave the main presentation at our press conference (that received international coverage); gave many interviews following that; wrote the fact sheet, and provided technical resources to those interested in implementing the model (e.g., the tools here).

I was asked to make a presentation on UCERF2 (described above) to the publically held *Governing Board Meeting of the California Earthquake Authority* on June 26, 2008.

Puente Hills Earthquake Study: On the day our paper (Pub. #36) was released, I gave the main presentation at a press conference that received national coverage (e.g., CNN's *Lou Dobbs Tonight*).

I was filmed for two television shows related to the Puente Hills earthquake:

- National Geographic Explorer show "*L.A.'s Future Quake*" that first aired on Sept. 9th, 2006.
- History Channel show "*Mega Disasters: LA's Killer Quake*" that also aired about that time.

We had a booth on OpenSHA at the 2004 annual meeting of the Seismological Society of America. April 14-16, Palm Springs, CA. OpenSHA was also part of a SCEC booth at the 2004 Fall AGU meeting.

I hosted a booth at the USGS/Caltech public "Earthquake Awareness Event" held on the 10th Anniversary of the Northridge Earthquake. January 17, 2004.

I gave a presentation on OpenSHA at a workshop on "Implementation of SCEC Earthquake Hazard Research Results in Earthquake Engineering Research and Practice". Sept. 22, 2003

I developed and maintained the RELM website (http://www.RELM.org), which now points to a brief summary at the CSEP website since the RELM project is over.

I gave a semi-technical presentation on SCEC's Phase III report (and the future of SHA in general) to EERI's Southern California Chapter meeting. November 15, 2001.

I presented an overview of the SCEC Phase III Report (accounting for site effects in PSHA) at the 6th Caltrans Seismic Research Workshop. June 12, 2001.

I conducted several media interviews in the aftermath of the Feb. 28, 2001 M 6.8 Nisqually Earthquake.

SCEC Phase-III report release: (in addition to the work I did on the report) I gave the main presentation at the press conference on January 16, 2001; gave interviews with several reporters, and appeared on two live local broadcasts that evening (KNBC's evening news and KCET's "Life and Times Tonight" program). I also wrote the Fact Sheet (Pub. #33), and contributed to the various Technical Resources for users.

I appeared in the "Earthquakes: Seismic Sleuths" video produced by Summer Productions for the Discovery Channel, 2000.

I gave a general overview talk on "Earthquake in Urbanized Sedimentary Basins" at the January 1999 meeting of the *American Association for the Advancement of Science*.

## 16. INVENTIONS, PATENTS HELD

## 17. HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIPS

USGS Star Award ($1,000) – Dec. 2008

> "The Earthquake Hazards Program wishes to recognize Ned Field for his leadership on the executive committee of the multi-agency Working Group for California Earthquake Probabilities. In his role he provided the intellectual and scientific management needed to develop improved methods for both time-independent and-dependent forecasting of earthquake occurrence, a "living" software model that allows the forecast to be updated in the event of a major earthquake or improved input data, and a statewide earthquake rupture forecast for California. The working group forecast has already had impact: the California Earthquake Authority has used the results to review its own reinsurance stance, has indicated plans to use the forecast to review earthquake insurance premiums, and is considering a program of further research based on needs identified in the Working Group report. Also, the forecast formed the California portion of the USGS and CGS seismic hazard map update released in 2008. For these efforts above and beyond the call, Dr. Field should receive a STAR Award in the amount of $1,000.00 gross."

USGS Unit Award for Excellence of Service – Sept. 2008

> "In recognition of outstanding contributions to the US Geological Survey in the development of seismic hazards assessments and design maps for use in building codes and other earthquake mitigation purposes. …"

USGS Star Award ($1,000) – Nov. 2007

> "The Earthquake Hazards Program wishes to recognize Ned Field for his leadership on the executive committee of the multi-agency Working Group for California Earthquake Probabilities. He has been the driving force for the development of the first-ever statewide earthquake rupture forecast that was delivered on time to the California Earthquake Authority. His efforts were key to this high-profile endeavor that will have a major impact on hazard mitigation in California. For these efforts above and beyond the call, Dr. Field should receive a STAR Award in the amount of $1,000.00 gross."

USGS Star Award ($1,460) – Nov. 2007

> "Because the Earthquake Hazards Program does not provide sufficient funding to cover all of the salaries and expenses of the Earthquake Hazards Team, funding from other sources is critical to the financial health of the Team. Significant work is required to obtain non-Program funds, and even more work is required to produce the products required by the funding contracts. This STAR award is for his unselfish efforts in helping the EHZ Team obtain reimbursable funding."

USGS Star Award ($1,530) – Sept. 2007

> "Ned is doing an outstanding job of leading the Working Group for California Earthquake Probabilities, and essential team product. This multi-year study, withy tight deadlines for its deliverables is on-track and on-time due to Ned's efforts. Ned has successfully brought in a very large amount of reimbursable salary OFA for this year for the CEA effort with SCEC. This is going to really help the Team, and deserves recognition."

USGS Special Thanks for Achieving Results Award – 2006

> "in recognition of your dedicated efforts critically assisting the Team by bringing in OFA monies, and for excellent leadership of the Working Group for California Earthquake Probabilities."

USGS Special Thanks for Achieving Results Award – 2005

> "in recognition of your outstanding efforts in developing the Regional Earthquake Likelihood Models program, developing OpenSHA suite of Java tools, and your able leadership of the Working Group for California Earthquake Probabilities."

USGS On-the-Spot Award ($500) - Aug. 2003

> For developing "novel modeling techniques [OpenSHA] to predict the probability of exceeding a given displacement on the Denali Fault at the crossing of the TAPS pipeline". This information was used by the Alyeska Pipeline Service Co. in deciding how soon to begin oil pipeline repairs following the November 2002 M 9.7 Denali Earthquake in Alaska.

Education & Outreach Award of the Southern California Earthquake Center, 2001.

Education & Outreach Award of the Southern California Earthquake Center, 1998.

Member, Phi Beta Kappa national honor society, 1988-present.

Graduated with Departmental Honors (magna cum laude), CU Boulder, Spring 1988.

University of Colorado, Boulder Geology Dept. Brunton Compass Award, Spring 1987.

University of Colorado, Boulder Geology Dept. Estwing Pick Award, Spring 1986.

University of Colorado, Boulder Dean's Scholarship, 1985-1986; 1986-1987; 1987-1988.

## 18. BIBLIOGRAPHY

### a. PUBLISHED REPORTS

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2. Hough, S.E., P.A. Friberg, R. Busby, E.H. Field, and K.H. Jacob (1990). Did Mud Cause Freeway Collapse?, *EOS, Trans. Am. Geophysical Union*, **70**, 1497-1504.

3. Hough, S.E., P.A. Friberg, R. Busby, E.H. Field, K.H. Jacob, and R.D. Borcherdt (1990). Sediment-Induced Amplification and the Collapse of the Nimitz Freeway; *Nature*, **344**, 853-855.

4. Hough, S.E., E.H. Field, and K.H. Jacob (1991). Using Microtremors to assess site-specific earthquake hazard, *Proceedings, 4th Int. Conf. on Seismic Zonation*, held at Stanford Univ., CA; August 25-29, 1991; EERI, Oakland, CA., **3**, 585-592.

5. Field, E.H., K.H. Jacob, and S.E. Hough (1992). Earthquake Site Response Estimation: A weak Motion Case Study, *Bull. of the Seismological Soc. of Am.*, **82**, 2283-2307.

6. Field, E.H., K.H. Jacob, N. Barstow, and P.A. Friberg (1992). Coachella Valley Site-Response Experiment Using Landers Earthquake Aftershocks in Southern California, *Bull. of the National Center for Earthquake Eng. Res.*, **6**, 8-11.

7. Field, E.H., K.H. Jacob, and S. H. Hough (1992). Earthquake Site Response Estimation: A Case Study Using Aftershocks of the 1989 Loma Prieta Earthquake Recorded in Oakland, California, *Proc of the Int. Symp. on the Effects of Surface Geology on Seismic Motion*; March 25-27, 1992, Odawara, Japan. **1**, 323-328.

8. Field, E.H., S.E. Hough, K.H. Jacob, and P.A. Friberg (1993). Site Response in Oakland, California, Near the Failed Section of the Nimitz Freeway; *NEHRP Report to Congress, The Loma Prieta, Ca., Earthquake of Oct. 17, 1989; Strong Ground Motion Chapter (R. Borcherdt, editor)*, U.S. Geological Survey Prof. Paper 1551-A, p. 169-180.

9. Field, E.H., and K.H. Jacob (1993). Monte Carlo Simulation of the Theoretical Site Response Variability at Turkey Flat Given Uncertainty in the Input Parameters, *Earthquake Spectra*, **9**, 669-701.

10. Field, E.H., and K.H. Jacob (1993). The Response of Sedimentary Layers to Ambient Seismic Noise: A Theoretical Model and Comparison with Both Observations and the Site Response Predicted for Earthquake Ground Motion, *Geophysical Research Letters*, **20**, 2925-2928.

11. Field. E.H. (1994). Discussion of "Variation of Site Response at the UCSB Dense Array of Portable Accelerometers" by J.H. Steidl. Earthquake Spectra, **10**, 451-456. and reponse by Steidl on subsequent pages 457-460

12 Field, E.H. (1994). The Effects of Surface Geology on Earthquake Ground Motion, *Ph.D. Thesis*, Columbia University, New York, October, 1994.

13. Field, E.H., A.C. Clement, V. Aharonian, S. E. Hough, P.A. Friberg, T.O. Babaian, S.S. Karapetian, S.M. Hovanessian, and H.A. Abramian (1995). Earthquake Site Response Study in Giumri (formerly Leninakan), Armenia Using Ambient Noise Observations, *Bull. of the Seismological Soc. of Am.*, **85**, 349-353.

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## b. REPORTS ACCEPTED FOR PUBLICATION

54. A paper on the UCERF3 time-independent model (publication 52 above) has been accepted to the Bulletin of the Seismological Society of America pending minor edits.

**19. PUBLICATIONS (three most significant)**

*Note – I'm tempted to put the UCERF3 time independent model here (Pub #52), but the various UCERF3 elements are still rolling out and the full impact has yet to be determined (even though it has been formally adopted for use in the national seismic hazard maps).*

1) Field, E.H. and the 2007 Working Group on California Earthquake Probabilities* (2008). The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2), *U.S. Geological Survey Open-File Report 2007-1437* [http://pubs.usgs.gov/of/2007/1437/], *California Geological Survey Special Report 203*, and in *Bull. Seism. Soc. Am*. **99**, 2053-2107.

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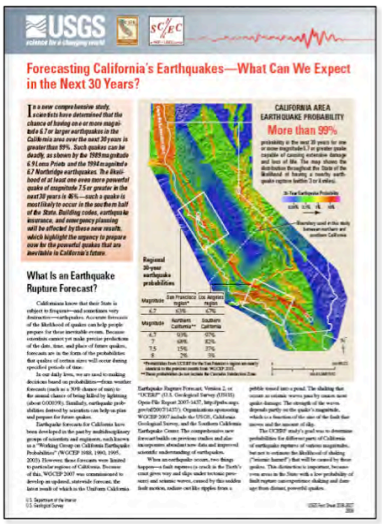
This is clearly my greatest-impact publication to date. I've already discussed UCERF2 in multiple places above, so I will only emphasize a few things here. First, it was the first uniform, statewide, and time-dependent forecast model ever developed by a formal working group. Second, publication involved extensive outreach including:

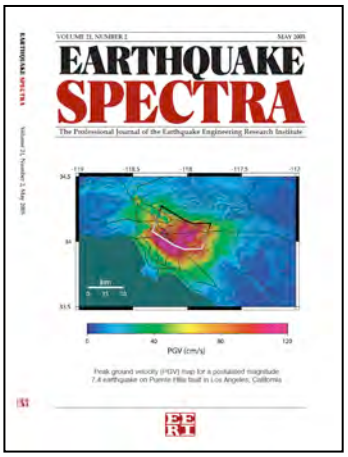



- Main Report (Pub. #45, which I first authored)
- 16 Appendices (I was first author on two – Pubs #43 & #44)
- Executive Summary
- UCERF2 Fact Sheet (Pub #46, which I first authored)
- Press Release
- Press Conference (also webcasted; I gave the main presentation; watch video here)
- Podcast
- Various Data, Software, and Analysis Tools

Third, UCERF 2 has already impacted the establishment of building codes (via the 2008 USGS national hazard maps), earthquake insurance (via the California Earthquake Authority), and emergency preparedness (via the Great Southern California ShakeOut). Fourth, given scrutiny applied by our Scientific Review Panel, both the National and California Earthquake Prediction Evaluation Councils (NEPEC and CEPEC), and the peer-review process for the *Bulletin of the Seismological of America* publication, one could argue that this is the most extensively reviewed forecast model ever developed. Fifth, this required coordination and collaboration between the Pasadena, Menlo Park, and Golden offices of the USGS, as well as with the California Geological Survey and the Southern California Earthquake Center. A project like this inevitably (and appropriately) involves some politics, and I am gratified that there were no really ugly moments. In fact, at the beginning of the project many I spoke with avoided the effort like the plague, but now people seem quite eager to get involved in our future developments. Finally, perhaps the greatest contribution of the UCERF2 report will be what I hope is a clear and honest articulation of what's wrong with the model, which we plan to address in UCERF3.

2) Field, E.H., H.A Seligson, N. Gupta, V. Gupta, T.H. Jordan, and K.W. Campbell (2005). Loss Estimates for a Puente Hills Blind-Thrust Earthquake in Los Angeles, California, *Earthquake Spectra* **21**, 329-338.

In this study (Pub. #36) we exemplified the use of OpenSHA's Scenario ShakeMap Calculator by conducting a hazard-to-loss analysis of an earthquake on the Puente Hills blind-thrust fault beneath Los Angeles. The purpose of this publication was to showcase two unique features of OpenSHA: 1) the ability to easily compute and analyze results for alternative models (e.g., different magnitudes and different ground-motion-prediction equations), which enables a quantification of uncertainties associated with statements of hazard and loss (without which one has no idea of the reliability of such statements); and 2) the fact that virtually anyone could have downloaded the application and done the analysis themselves (in fact, we give instructions on how to do so at our web site). The latter was also exemplified by a SCEC intern subsequently doing an equivalent analysis for the Rose Canyon fault in San Diego (Loren Wimmer, poster at the 2005 SCEC annual meeting), which she achieved after just one face-to-face meeting with me. With respect to the Puente Hills earthquake, our study found that losses would be between $82 and $252 billion, making it arguably the worst-case earthquake scenario for the United States (although not the most probable event). This fact generated renewed and increased interest in our study following hurricane Katrina. For example, our paper was explicitly mentioned on page 25 of a US Government Accountability Office report on "Natural Hazard Mitigation" to the Ranking Member, Committee on Financial Services, House of Representatives (GAO-07-403, Aug. 2007). I should probably also mention that we held a widely covered press conference when our paper was first published (info here), and I also discussed this study on a National Geographic Explorer show called "*L.A.'s Future Quake*" that first aired on Sept. 9th, 2006, as well as on the History Channel show "*Mega Disasters: LA's Killer Quake*" that also aired about that time.




3) Field, E.H., P.A. Johnson, I.A. Beresnev, and Y. Zeng (1997). Nonlinear ground-motion amplification by sediment during the 1994 Northridge earthquake, *Nature*. **390**, 599-602.

This was the first widespread documentation of nonlinear site response in southern California (by nonlinear we mean that the difference in ground motion between a rock and a sediment site, or the "amplification", depends on the level of shaking - a violation of Hooke's Law that tress is proportional to strain). Up until that time there had been general disagreement between seismologists and engineers regarding the significance of nonlinear sediment amplification, especially for the relatively dry soil conditions that typify southern California. To resolve the issue, I devised a test using observations of the Northridge main shock and its aftershocks at all sites where both were recorded. Via careful statistical analysis I was able to show that amplification factors for the strong-motion main shock were significantly less that those for the weak-motion aftershocks. The results were published in the journal *Nature* (Pub. #19), and a more extensive treatment was published in the *Journal of Geophysical Research* (Pub. #21). In light of these results and remaining questions, I organized and led a two-day international workshop on the topic where there was widespread agreement among the 60 attendees that sediment nonlinearity was the culprit of the reduced amplification factors (Pub. #22 is a report on this workshop). In addition to helping solidify a new perspective in the seismological community, I include this study here because it represented a very simple test of a basic scientific hypothesis (the quintessence of what we do as scientists, which is easy to forget as we get swept up into working groups and community efforts).

20. POSITION DESCRIPTION (Attached)

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